

Jacobson, Arne (1999). "Case Study 14: Rural Electrification in Ladakh, India" in Chapter 16, *Special Report on Methodological and Technological Issues in Technology Transfer*, Inter-governmental Panel on Climate Change (IPCC) Working Group II. <http://www.grida.no/climate/ipcc/tectran/342.htm>

## **Successes and Setbacks: Rural Electrification Using Photovoltaics in Ladakh, India**

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**Keywords:** Ladakh, India, photovoltaic, rural electrification, S⇒S

### **Summary**

In the Ladakh region of India, government funded photovoltaic (PV) systems are used for rural electrification. The system capital costs are covered by the government; homeowners must pay for maintenance costs. Systems have been installed by several agencies. One, an NGO called the SWRC, has successfully installed long lasting systems. Two contributing factors to their success are the SWRC's development of a maintenance infrastructure for PV systems and Indian government standards on the design and installation of PV systems.

The SWRC's success contributes to a high demand for PV among Ladakhi villagers. Local policy makers have responded by allocating money for PV. However, the focus is on installing new systems, not on building a maintenance infrastructure. There is a danger that despite the SWRC's positive example, a large number of PV systems will be installed without provision for maintenance.

### **Background**

Ladakh is an isolated high desert in northern India. The 100,000 sq. km region is sparsely populated by subsistence farmers and nomadic herders (pop. 170,000).

Approximately 85% of the population has some access to electricity. Plans are in place to electrify the remaining portion in the next few years, mostly using PV.

Barriers for PV electrification include mountainous terrain, bad roads, a harsh winter climate, low population density, and a lack of skilled technicians and managers. To date low rural per capita income (estimated at \$US45) has

not proven problematic, but only because of large subsidies.

### **Approach**

PV electrification is funded by the Indian Government. Funds are distributed to NGO's and private contractors through state and local government agencies.

PV systems cost about \$US450, and consist of a 35 watt solar panel, a 75 Ahr deep cycle battery, a charge controller with low voltage disconnect, and 2 fluorescent lamps (9-11 watt). The winter solar resource in Ladakh allows for three hours of lighting per day.

PV systems are popular among villagers and policy makers. Reasons include low cost per electrified family, short installation times, and a reputation for reliability. Of 200 surveyed systems, 71% were fully functional, 27% were partially functional, and 2% were non-functional. However, the average age of the surveyed systems was only 2.4 years; more failures are likely to occur in time.

The short term success of the systems is in part because government standards require the use of quality components.

### *PV System Maintenance:*

There are two arrangements for maintaining PV systems. The most common is a one year warranty on parts and labor. After one year these systems generally are not properly maintained, as family incomes are low and no businesses in Ladakh service PV systems or sell the appropriate components.

Approximately 1,000 of the systems were installed by the Social Work and Research Center (SWRC), a local NGO in the Tilonia school network in India. The SWRC has done an excellent job of developing a village level maintenance infrastructure for servicing its PV systems. The program includes an extensive hands-on training program for village technicians. Homeowners pay a monthly fee (\$US0.70, covers ≈50% of the post-technician training maintenance cost) in exchange for a ten year maintenance contract. Many of the SWRC systems still operate with their original batteries; a few of these systems are ten years old.

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Unfortunately, system owners who are not in the SWRC network do not have access to their maintenance program; this is due in part to the large distances between villages.

#### Success of PV Leads to More Installations:

The demand for electricity in Ladakh and the success of the SWRC's PV electrification program have created pressure on local officials to install more systems. The response was to allocate funds for 2,000 systems for 1997-99.

However, most of these installations will not follow the SWRC's methodology. Instead, the focus is on installing new systems; little money or time is allocated to developing a maintenance infrastructure. This approach will likely result in future problems, as systems that are not maintained will fail prematurely.

#### **Impact**

Approximately 5,000 PV systems are installed in Ladakh; 25% of the population is receiving electricity from solar energy. However, 70% of these installations have occurred in the last three years, and lack of maintenance may prove problematic.

#### **Lessons Learned**

- The long life of the SWRC installed systems contributes to the positive reputation of PV, but has not lead to the development of a maintenance infrastructure for the larger number of PV systems installed by other agencies.
- Several elements contribute to the success of SWRC installations:
  - Systems are installed using quality components according to government design standards.
  - Systems are maintained carefully by village level technicians. Spare parts are available.
  - Lack of funding is not an issue due to subsidies. Replication of this work will require access to capital.

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